A Program of Detector Evaluation and R&D for Future Lepton Colliders

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In preparation for a recent review of the electron-based research program at the HEP laboratories, representatives from the five labs (Argonne, Berkeley, Brookhaven, Fermilab, and SLAC) developed a short position paper outlining a possible evolution of detector related studies for future lepton colliders. The intent was first to create a framework for presenting individual laboratory detector R&D proposals over the coming three years, and second to initiate a broader discussion in the US HEP community of a coherent, long-term lepton collider strategy. Eventually, we envisioned that the position paper could be turned into a proposal to DOE and NSF for funding and support of lepton collider detector studies both at universities and laboratories. As an initial step in this direction, we have kept US leadership of the ILC effort and the DPF Executive informed of the position paper. We are now sharing a white paper derived from the original presentation with the larger DPF membership as the next step in the process of developing a proposal.

For several years, there has been a strong international consensus that an e^+e^- collider will be needed to study the underlying physics of the new phenomena in the mass range from 0.2 - 1.0 TeV, which are expected to be discovered at the LHC. The International Linear Collider (ILC) is pursued by a world-wide GDE-coordinated R&D effort aimed at producing a technical design by the end of 2012. An associated international effort to establish integrated detector concepts and evaluate physics performance has also been organized within the auspices of the ILC. Other lepton collider options are also being pursued, including the Compact Linear Collider (CLIC) and various warm variants, and the muon collider (MuC). These options, while at different stages of development, are capable of extending the energy reach of lepton colliders to 3 or even 4 TeV.

While the machine parameters and background conditions for these lepton collider options vary considerably, the broad physics goals are similar. The role of a lepton collider is to enable precision measurements of the new particles discovered at the LHC, thereby elucidating the underlying physics. Although the superconducting RF technology for the ILC is the most mature, physics discoveries at the LHC may point to higher energies than can be achieved with this technology. The delayed startup of the LHC also means that physics discoveries may come somewhat later than envisioned a few years

ago. It is therefore prudent for the international community to pursue a broader range of lepton collider options. We argue the need for a unified single US program to support simulation and evaluation of physics performance, and the coordination of detector R&D for future lepton colliders. The goals of such a program could include:

- Enabling US participation in the development of the physics and detector program of lepton colliders;
- Coordination of US efforts within the global physics and detector efforts;
- Defining the physics case and the required detector and machine performance;
- Determining whether existing detector concepts can be used or defining required detector concepts (if they do not exist);
- Comparing the physics potential of all options on an equal footing
- Evaluating and making use of existing software frameworks to do the work, thereby avoiding duplication and improving efficiency;
- Defining the R&D needs of the detector concepts; and
- Providing guidance on priorities and monitoring related detector R&D, including defining a program that can be executed within a specified budget.

Over the next few years, we will better understand from LHC results the physics case for a future energy-frontier lepton collider. We will better understand the options, challenges and technical solutions through R&D and design activities directed towards future lepton colliders. In order to make informed decisions about our overall strategy for realizing an energy-frontier lepton collider, we will also need to understand the physics capabilities and detector challenges for these collider options with a consistent approach. We therefore believe that a common program of detector performance evaluation and coordination of detector R&D should be established for lepton colliders.